International Journal of
Science and Engineering Investigations vol. 6, issue 61, February 2017
ISSN: 2251-8843

Artificial Intelligence, Robotics and Its Impact on Society

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Abstract- In this paper a general overview and the under lying concepts of Artificial Intelligence (AI) and Robotics is presented with the main emphasis on the how the present day robots and the future of Artificial Intelligence and Robotics would impact the society and the social life at large.

Keywords- *Artificial Intelligence, Robotics, Social Life*

I. INTRODUCTION

With the growing interest in Artificial Intelligence and Robotics in the areas of medicine, manufacturing, military, and household applications, there is a push to increase the usage of robots and machine learning in these areas. Over the years, machines and computers have performed various tasks and this process seems to be growing exponentially over time. The idea of combining these machines together with the computational power of computers to act or think in a way humans do, creating computers or machines as intelligent as human beings, has existed for some time. Early research by Alan M. Turing who published "Computing Machinery and Intelligence" in 1950 and who is best known for "The Imitation Game" in which the question "Can machines think" is considered and evaluated. This question has led to the rise of many researchers such as Marvin Minsky, John McCarthy, James McClelland, David Rumelhart, and Lofti Zadeh, resulting in a substantial amount of work in the area of Artificial Intelligence.

Marvin Minsky and John McCarthy, both cognitive scientists at Massachusetts Institute of Technology (MIT), formed the MIT Artificial Intelligence lab, where a considerable amount of work was done in regards to Perceptrons and towards establishing a framework for knowledge representation. In fact, John McCarthy has been credited for coining the term "Artificial Intelligence". James McClelland and David Rumelhart researched parallel distributed processing (PDP), an artificial neural network approach based on the nature of parallel neural processing with a general mathematical framework. Lofti Zadeh contributed towards "Fuzzy Mathematics", important approaches in the areas of Artificial Intelligence ("Connectionism", 2016).

Robots are machines that are most often programmed by a computer. They are capable of performing a series of complex actions automatically. Robots can be utilized by using either an external device (such as a remote control) or through a device that is implanted within the robot itself. The term "robot" was first used by the Czech writer, Karel Čapek his 1920 play, R.U.R. to depict a fictional humanoid. The first digital and programmable robot was invented in 1945 by George Devol. In 1961, it was sold to General Motors for the purposes of lifting hot pieces of metal ("Robot", 2016).

II. ARTIFICIAL INTELLIGENCE (AI)

John McCarthy, the father of Artificial Intelligence, defined it as "The science and engineering of making intelligent machines, especially intelligent computer programs". Artificial Intelligence is a way of making computers and computer-controlled machines and software to be intelligent enough to learn, decide, and execute in a manner similar to that of the way a human brain thinks and acts. In a nutshell, the aim of Artificial Intelligence is to create intelligence in machines that would closely emulate the intelligence of human beings. Artificial Intelligence is generally considered to be concerned with applying computers to tasks that require knowledge, perception, reasoning, understanding, and cognitive abilities.

Artificial Intelligence is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering. The major emphasis of AI is in the development of computer functions associated with human intelligence such as reasoning, learning, and problem solving. The AI method employed should be able to receive information, organize, build up knowledge, and use it efficiently such that it is understood by the people who provide the information and should be able to modify in order to correct the errors arising in the buildup process. During the process of knowledge build up, it is likely that the decisions made are either incomplete or not highly accurate, but useful in many situations ("Artificial Intelligence for Beginners", 2015).

A. The Imitation Game (Turing Test)

In 1950, Alan Turing formulated the problem "The Imitation Game", also known as the Turing Test, in order to find an answer to the question "Can machines think?"

The 'imitation game" is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. This is to be done by asking questions to both A and B in the

form of written messages so that the interrogator cannot determine whether it is man or woman through the voice. The interrogator would then decide the identification of A and B based on the responses to his compiled questions. Now when a machine takes the part of A in this game, replacing the man (A), will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman? "Can machines think?"

The formulation of this problem was in an effort to successfully construct a thinking machine. Alan Turing was truly a visionary who was ahead of his time. He believed that with a powerful programmable computer paired with a large storage capacity, the question "Can machines think?" would be answered. Hence, he believed that machines could be taught to play the imitation game so well that an average interrogator would not have more than a 70% chance of making the right identification after 5 minutes of questioning, in which case the machine is said to have passed the test.

However, according to Turing, there are a number of results of mathematical logic which can be used to show that there are limitations to the powers of discrete-state machines. The best known of these results is known as Godel's Theorem (1931). Godel's Theorem shows that in any sufficiently powerful logical system statements can be formulated which can neither be proved nor disproved within the system, unless the system itself is inconsistent.

Finally, consider a digital computer with enough processing power and a large storage capacity. If it is rigged up to give answers to questions as in the imitation game and given an infinite amount of time to reply, there will be some questions to which it will either give a wrong answer or fail to give an answer at all (Turing).

B. Components of Artificial Intelligence (AI)

Intelligent computer systems should be able to perform operations such as calculation, reasoning, perception of relationships and analogies, learn from experience, information storage and retrieval, problem-solving, natural language processing, classification, generalization, and adaptation.

Artificial Intelligence is composed of the following:

1) Problem-Solving

One of the roles of AI is problem-solving – in which games such as chess, tic-tac-toe, and poker are played using the heuristic knowledge-based rules stored in order to determine the best possible move given the largest number of moves possible.

2) Logical Reasoning

Logical reasoning is a set of processes that enables us to provide a basis for judgment and making decisions and predictions. Logical reasoning uses a minimal set of facts for deduction, solving complex mathematical equations and proving theorems. The two types of reasoning that are used include inductive reasoning and deductive reasoning. Inductive reasoning is based on specific observations which are suitably combined in order to reach a broad generalization. Deductive reasoning starts with a hypothesis or broad generalization and examines the possibilities to reach a logical conclusion.

Inductive Reasoning:

Anusha is a girl
Anusha works hard
Therefore, All Girls work hard → Broad generalization

Deductive Reasoning:

All Girls word hard → Broad generalization
Anusha works hard
Therefore, Anusha is a girl

3) Natural Language Processing

Natural language processing is the interaction with computers, involving query retrieval, translation from one written language to another, and text comprehension. Handwriting recognition software reads the text written on paper, and then recognizes the shapes of the letters and converts it into editable text. In speech recognition, systems are capable of hearing and understanding the language in terms of sentences and their meanings, while a human talks to it. It has the capability to recognize different accents, noises in the background, and any changes in the human's voice (for example, changes in the voice due to a cold).

4) Learning

Learning is the process of acquiring explicit knowledge or new skills by studying, practicing, being taught, or experiencing something. Learning can be in the form of listening, hearing, remembering such as a sequence of events, playing, watching, writing, identifying, and classifying.

5) Expert Systems

Expert systems are the computer applications developed to solve complex problems in a particular domain at the level of extraordinary human intelligence and expertise. They can be used in prediction, advising, diagnosing, and decision making. Expert systems consist of knowledge engineering, inference mechanisms, and rule learning. Knowledge in the form of data, information, and rules is acquired and organized in a way that it is suitably represented. The inference mechanism, with its procedures and rules, operates upon the stored or acquired knowledge to arrive at a decision or solution.

6) Vision

These systems analyze and interpret visual input on the computer. In the case of a medical diagnosis, doctors can use clinical expert systems to diagnose the patient using the digital image scans. In the case of a crime, police can use computer software that can recognize the face of a criminal with a sketch made according to the description given by the witness (es) (Schank, 1987; "Artificial Intelligence for Beginners", 2015).

C. Machine Learning

Machine learning is the ability of the computer(s) to learn without explicitly being programmed. The machine can be tutored in a supervised manner or it can learn on its own in an unsupervised manner. Speech recognition and image recognition are some areas where machine learning is used. Historically, Automatic Speech Recognition (ASR) has been one of the main driving forces for machine learning. Even after many years of research and development, ASR is still an unsolved problem in spite of applications like Siri in Apple's iPhone. Speech recognition is based on the Hidden Markov

Models (HMM), which can be trained in the supervised mode while it can learn, adapt, and update itself in an unsupervised mode. The accuracy of speech recognition is questionable, as the conditions do not match well with the training conditions.

Enlitic is a company that wants to employ computers to make diagnoses by scanning images via machine learning. They want to teach computers to recognize a variety of different injuries, diseases, and disorders by providing them with many X-rays, MRIs, CAT scans, and other types of scans. So, the computer will be able to spot a possible problem and then flag it for the doctor to take a look. This will make it more efficient and easier to detect and diagnose diseases. Yet, this process is not meant to replace the physicians (radiologists). This process still requires a lot of work, however, in order for it to be used in healthcare fields (Garling, 2014).

D. AI in Medicine

In AI, the problem-solving methods or approaches may not be mathematical or data-processing methods, but reasoning techniques that relate to items based on heuristics. Heuristic methods, on the other hand, are not guaranteed to work, but will find solutions in a much shorter time than a brute force method. In medicine, the issue is that few problems have algorithmic solutions that are both practical and valid. Thus, this is why physicians are expected to reason the illness based on the judgmental rules and empirical associations.

MYCIN, an expert system developed for diagnosing bacterial infections, consists of two main parts: a knowledge base (built with the help of interaction with the users to help line of reasoning) and an inference engine (for making decisions). The knowledge base contains facts and associations about a subject area, such as medicine. The inference engine contains rules, which can be invoked in two ways: forward chaining or backward chaining.

In forward chaining, or data-directed inference, the conditions are evaluated, and if they are all satisfied the action takes place.

If A then B (Rule 1)
If B then C (Rule 2)
A → (Data)
Therefore C (Conclusion)

In backward chaining, or goal-directed control strategy, the action part is initially assumed to be true so that for this to be true, the conditions must also be true.

Find out about C (Goal)
If B then C (Rule 1)
If A then B (Rule 2)
Therefore, if A then C (Implicit Rule)
Question: Is A true? (Data)

Additionally, MYCIN is a rule-based expert system, which primarily uses backward chaining, or goal-directed strategy.

An example of a rule from MYCIN:

IF the infection is primary bacteremia
AND the site of the culture is one of the sterile sites
AND the suspected portal of entry is the gastrointestinal tract
THEN there is suggestive evidence (0.7) that the identity of organism is bacteriodes (Buchanan and Shortliffe)

E. Weak AI and Strong AI

1) Weak AI

Weak AI is focused on one task, such as playing chess or tic-tac-toe, where the system is not designed to think, but search for the best move within its database of rules and strategies that has been compiled by the human overtime. Household devices such as Roomba from iRobot and washing machines from Samsung with pre-programmed rules are examples of weak AI. Another case of weak AI is Siri in Apple's iPhone, which can answer simple questions, but often cannot answer difficult questions which are not within its limits. Another example, similar to Siri, is the machine-based answering service, which can answer selected questions for which it has been designed to. Therefore, weak AI systems have been designed more for problem-solving than for thinking and learning.

2) Strong AI

Strong AI systems can be designed to closely emulate the human brain by making it to be intelligent and to understand, perceive, have beliefs, and exhibit some of the behavior of human beings. Strong AI systems would have several components of Artificial Intelligence discussed above and more, in order to emulate the human brain to an extent that it matches or exceeds it. Strong AI systems are expected to think above and beyond the programming guidelines given to it, allowing it to intellectually resemble the human brain. Examples of strong AI are the robots shown in movies such as *The Terminator* and *Iron Man*. However, currently, strong AI machines are quite far from becoming a reality.

III. ROBOTICS

Isaac Asimov, part of the 1945 alumni of Columbia University, coined the term "Robotics". Robots are made out of hardware, which acts as an agent to perform certain defined tasks by manipulation. Robots by themselves are dumb and have no built-in intelligence. Robotics is the area that combines the hardware aspect of the Robot and Artificial Intelligence in making the Robot intelligent, making it capable of performing tasks without human supervision. However, Robots are operated in both supervised and unsupervised manners. Robots can be in form of manipulators (used in manufacturing), mobile robots (such as the ones used to automate transport in production processes), and humanoid robots (which have a resemblance close to that of a human being).

Robotics is concerned with the connection of perception to action. AI provides the intelligence by addressing what knowledge is required in the aspect of thinking, representation of the knowledge, and how it is to be used, thus making Robots intelligent. AI contributes to the effectiveness of how the components in a Robot (mechanical effectors, sensors, and computers) are to be used. Intelligent Robots are used in

present-day manufacturing, assembly, cleaning, painting, and providing other services. In medicine, Robots are being used in neurosurgery and in treating cancer patients. Use of Robots for household services, such as cleaning and surveillance, have increased and will continue to do so as time goes on.

Major service providers are now planning to provide home-based robotic services to help the sick and aged who are home alone. In Japan, Robots are being used to guide the blind. In addition, humanoid Robots are being tested and evaluated for deep space travel and exploration by NASA. Since extreme space conditions are quite dangerous for humans (space expeditions to Mars and other planets), autonomous Robots with dexterity are required. Areas such as human-robot interaction, constrained motion planning and control, and grasping of unknown objects are considered to be crucial and are being tested and evaluated with the strategy of achieving full autonomy ("Artificial Intelligence for Beginners", 2015; Niemueller and Widyadharma, 2003).

A. Components of an Intelligent Robot

The block diagram in Figure 1.0 shows the various components of an intelligent Robot.

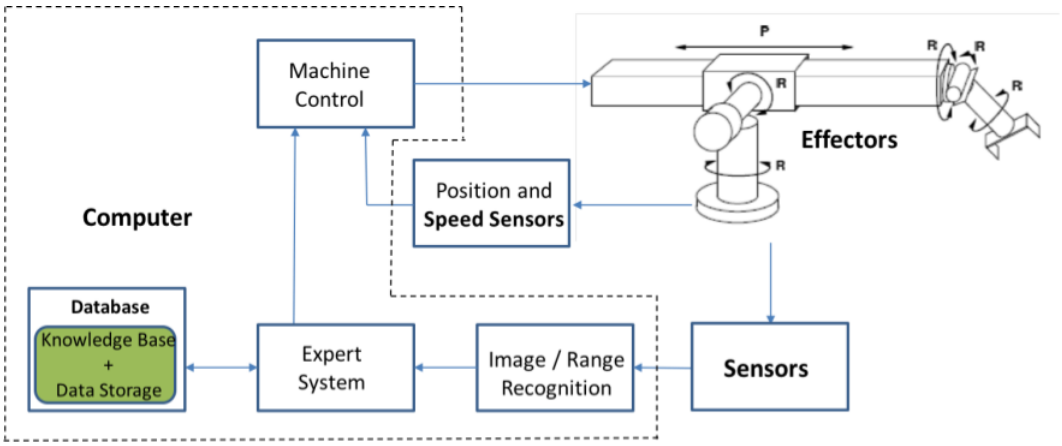

Figure 1. Components of an Intelligent Robot

1) Sensors

Sensors are the perceptual interface between the Robot and its environment. Sensors essentially fall into two categories: active sensors and passive sensors. Active sensors, such as sonar, laser, and radar, are generally used for distance measurements, such as length or depth, to determine the position of the Robot relative to the object. In order to do so, they emit energy, and the reflected energy received is used to determine the distance. Close range sensors are ultrasonic sensors, while long range sensors are GPS sensors. Sensors could also be audio sensors for hearing and understanding commands, speech, and messages. Passive sensors, like cameras, are used to gather images of the environment, so they can be analyzed using computer vision and image recognition techniques. In the planning for a robotic assembly, AI defines knowledge required for reasoning, knowledge representation, and its use, as well as gathering information to update the generated plans, knowledge base, and world model.

2) Effectors

Effectors are the ways and means by which Robots manipulate their environment by either moving or changing their shape. Effectors consist of wheels, grippers, and revolute joints. Six degrees of freedom (DOF) are generally required to effectively move and place an object from one place to another. The three axes *(x, y, z)* form the three degrees of freedom and the other three degrees of freedom are *roll, pitch, and yaw*. A Robot is easier to control when it has more degrees of freedom. Figure 2.0 shows a Robot arm manipulator having six degrees of freedom with five revolute joints (R) for rotation and a prismatic joint (P) for sliding.

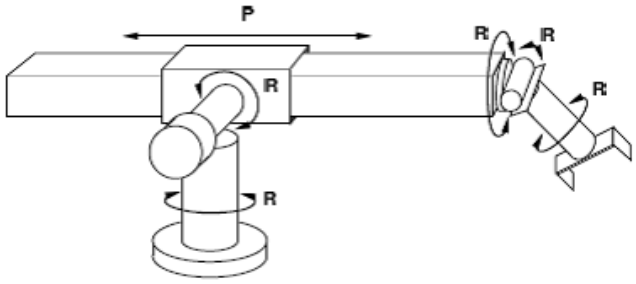

Figure 2. Robot Arm Manipulator

Mobile Robots have wheels, tracks, and legs. They use these to move from one location to another.

3) Computer

In this case, the Artificial Intelligence programs consisting of the number of its components resides on the computer. The computer used could have a single processor or multiple

processors. The raw data from the sensors is gathered, structured, and stored in the database. The data is processed for the Robot to make the right decision, in terms of moving or performing the related tasks correctly. The tasks that can be performed by the Robot are implicitly determined by a number of primitive and sensory capabilities. These capabilities are constantly improved and updated upon. The programs specify how the primitive capabilities are applied to a given task. The Robot needs to be programmed in order to perform the specified task. For one of the methods, in the case of industrial robots, the programmer, using an interactive device, enters the information of their expected position and orientation at certain sub-goals in the assembly task sequence. This information, consisting of mathematical models, parameters, attributes, and so on, are assigned to various objects that are required in the workspace ("Artificial Intelligence for Beginners", 2015; Niemueller and Widyadharma, 2003).

B. Guided Robots and Autonomous Robots

1) Guided Robots

Guided Robots consist of "eyes" in the form of one or two cameras which send video information back to the operator who then uses the video information to drive the Robot to its location and perform the necessary task(s). The operator is usually in a remote location (not in the line of sight of the Robot or cannot see the Robot, except the environment of the Robot through the video information it sends back). Another form of guided Robots is the Vision Guided Robots (VGR) which use the video information for monitoring, positioning, and performing the required tasks, especially in manufacturing (in a production plant). In the case of an Automated Guided Vehicle (AGV), which is a mobile Robot, markers or Robots tracks (sometimes called are waypoints) are used for the navigation of the Robot. They are used mostly in industrial environments for the transportation of large packages from one place to another within the warehouse ("Vision Guided Robotic Systems", 2016; "Automated guided vehicle", 2016).

2) Autonomous Robots

Autonomous Robots have intelligence incorporated into them, so that they are capable of performing required tasks without human intervention in an unsupervised manner. Autonomous Robots perform tasks with a great degree of autonomy. This is required for certain tasks such as household cleaning, painting, and delivery of goods. They are able to gain information on the environment in which they operate, while learning and quickly adapting to their changing environment as well. These Robots are capable of operating in underground tunnels, underwater, and in the air. Robots such are MDARS, from General Dynamics, and Cataglyphis, from NASA, are autonomous Robots built for outdoor navigation and are capable of decision making, sample detection, retrieval, and return capabilities ("Autonomous robot", 2016).

IV. IMPACT ON SOCIETY

Will robots take over the world? Will robots crush the human race? Will we become the biological slaves of robots? Or more realistically, will robots take our jobs? The idea that robots will replace humans in the workplace is a growing threat for many. Already, humans are facing this problem, with many being displaced from their jobs and their robotic replacements showing up for work instead. There many pros and cons when it comes to this topic, along with many ethical issues. Would you allow a robotic car drive you? Would you trust a robot to operate on you? Would you trust a robot to prescribe medications for your aging mother? Would you like robots to fight wars for your country? More importantly, whose fault is it when something goes wrong? Would the blame reside on the owner of the robot or the builder of the robot? As robots continue to penetrate into our daily lives, these questions need answers.

A. Jobs

Although many would like to blame engineers for creating robots and thus leading to those robots taking other people's jobs, engineers are also creating their own robotic replacements through this process. Robots can very easily replace engineers in the fields of software development and coding. Jobs that have the greatest risk of being taken over by robots/ intelligent machines include: roofers, accountants, translators, electrical and electronic equipment assemblers, postal service workers, jewelers and precious stone and metal workers, cooks, grinding and polishing workers, cashiers, bookkeepers, legal secretaries, fashion models, drivers, credit analysts, milling and planing machine setters, operators, and tenders, packaging and filing-machine operators and tenders, procurement clerks, umpires and referees, tellers, loan officers, timing device assemblers and adjusters, tax preparers, and telemarketers. Jobs that have already been taken over by robots/ intelligent machines include: stockroom workers, bartenders, pharmacists, farmers, bomb squad, journalists, and housekeepers. Jobs that have the least risk of being taken over by robots/ intelligent machines include those associated with: creative arts (dancers), professional sports (athletes), healthcare and medicine (social workers and psychiatrists), education (teachers), quality assurance (error management), and politics and law (legal leaders, lawmakers, judges, and juries) ("9 Jobs Most Likely to be Taken Over by Robots", 2016; Elkins, 2015; Hill, 2015; Lee, 2014; Lucky, 2016).

B. Driverless Cars

Driverless cars have now become a reality through new and advanced technology, but with all good things come the bad. The invention of driverless cars is meant to ease people's commute to and fro. But, what happens when something goes wrong? One such example could be a self-driven car given the task of taking you to your friend's party on time. In this scenario, the car will drive at the fastest speed possible, taking the shortest route, violating all the speed limits, and trespassing all of the properties in the neighborhood possible, while also killing and injuring many people along the way. Who will be responsible for the damage done? Who will be responsible for the medical bills of the injured? Will the car's owner be responsible or will it be the car's manufacturing company? These ethical issues need to be faced before putting driverless cars jumping with joy about the invention of these cars. And, what about all of those taxis? Will driverless cars replace them, putting thousands of taxi drivers out of work, as they transport

people to their destinations? As the technology associated with driverless cars increases and as engineers fix the outstanding problems, driverless cars will become a common sight on the roads, displacing thousands of workers (Goodall, 2016).

C. Dr. Bot

Robotic surgery has become a growing trend in the health field. Robotic surgery enables doctors to navigate the robotic arms via a console into the small cavities of the human body. This procedure allows for better accuracy and efficiency. Robotic surgery also allows for doctors to perform surgery on their patients while not being in the same place. For now, most robotic surgery is controlled or monitored by physicians, but what will the future be like? In time, will people have gained enough trust in robot doctors? Maybe the next time you lay down on the operating table, you may look up to see Dr. Bot hovering above you (Strickland, 2016).

D. Killer Robots

Robots are being used across the world for many purposes and organizations, including the military. Currently, the use of robots in the military can be seen through unmanned tanks and drones and by robotic weapons. Using robots for military purposes can reduce the rate of human fatalities. Robots can also reduce the amount of necessary manpower. On the other hand, what if the superintelligence acquired is used for purposes of destruction? This could prove to be devastating. Autonomous weapons programmed to kill in the hands of a wrong person could easily lead to mass destruction. These weapons could also be designed to be extremely difficult to turn off once they are set in the "arm mode", which can be used to essentially to thwart the enemy. In cases like this, humans who have designed such systems might not have control over such situations. There is also a grave danger when these Robots are given ambitious tasks, which in the process of achieving it, could wreak havoc on the ecosystem. How will a robot know the difference between friend or foe? And more importantly, what will happen when a robot accidently kills a person on the same side as it? Who is to blame (Guizzo and Ackerman, 2016)?

E. Pros and Cons

Although the thought of robots doing the chores around our house fill us with joy, how will we feel when robots start to replace us when it comes to our jobs? With technology advancing each day, this may become a reality. And with this new technology, comes many questions that need answers. What will happen to humans when robots start to replace them in the workplace? Where will robots advance from there? From our workplace to the White House? How would people feel with a robot for president? Therefore, although robots can make our lives easier there are many downfalls as well.

In recent times, research and development in the areas Artificial Intelligence, Robots, and machine learning has enabled the building of cost-effective intelligent Robots for domestic, industrial, military, and space applications. So, the question is "Would Robots take the jobs away from the human workers?" As the emerging technologies can reduce costs and improve speed, quality, and services, there is a danger of these workers losing their jobs to Robots. Rapid increase in the number of industrial Robots due to their falling prices in automation is already being felt throughout the economy. The very fact that they can work continuously without being interrupted all day, make them cost-competitive with human workers. The finance sectors, like Wall-Street, will see the use of AI software when it comes to executing stock trades in a fraction of a second. This would not possible in the case of a human worker. As years go by, these technologies and software will become cheaper and will be used in more applications. This process will end up displacing workers in large numbers, thus creating an economy that employs fewer workers. Therefore, a strategy needs to be developed, in not only proving benefits to the displayed workers, but also finding out ways and means to help them get back – such that there will be some work for each of them (West and Karsten, 2015).

Currently, research in the areas of Artificial Intelligence and robotics is being considered for security, verification, validation, and control. Controlling cars, airplanes, power grids, etc. are some of the applications of weak or narrow AI. In the long term, the quest for strong AI will continue and if it succeeds, it will perform better than humans at all cognitive tasks. These systems would continue to improve their cognitive abilities, which would enable these Robots to be far superior to that of the human intelligence, making them super intelligent. These super intelligent Robots perhaps might help us to eradicate war, disease, and poverty, making life better for mankind. The only question by the experts that remains is if strong AI and super intelligent Robots are things that can be achieved with our present-day technologies and the knowledge that is currently available.

V. CONCLUSION

Future research will be based on Artificial Intelligence with Deep Architectures and Deep Learning Algorithms. Presently, the problem with this is that training takes a long time. This approach should help machines think like humans, and thus making Strong AI a reality.

Further research is required in the areas of sensors, where touch and feel need to be perfected, since building Robots resembling humans would require them. So, with the present technology at hand, can we really build Humanoids that represent a human being? And, will robots take over the world? Who knows? Only time will tell.

REFERENCES

[1] 9 Jobs Most Likely to be Taken Over by Robots. (n.d.). Retrieved December 28, 2016, from http://www.salary.com/9-jobs-taken-over-by-robots/

[2] Artificial Intelligence for Beginners. (2015), Tutorials Point (I) Pvt. Ltd.

[3] Automated guided vehicle. (2016, December 25). Retrieved December 28, 2016, from https://en.wikipedia.org/wiki/Automated_guided_vehicle

[4] Autonomous robot. (2016, December 27). Retrieved December 28, 2016, from https://en.wikipedia.org/wiki/Autonomous_robot

[5] Buchanan, B. G., & Shortliffe, E. H. (n.d.). Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project, Addison-Wesley Publishing Company.

[6] Connectionism. (2016, December 19). Retrieved December 28, 2016, from https://en.wikipedia.org/wiki/Connectionism

[7] Elkins, K. (2015, May 29). The 20 jobs that robots are most likely to take over. Retrieved December 28, 2016, from http://www.businessinsider.com/jobs-robots-are-most-likely-to-take-over-2015-5

[8] Garling, C. (2014, August 22). A Startup Hopes to Teach Computers to Spot Tumors in Medical Scans. Retrieved December 28, 2016, from https://www.technologyreview.com/s/530261/a-startup-hopes-to-teach-computers-to-spot-tumors-in-medical-scans/

[9] Goodall, N. J. (2016, June). Can you Program Ethics into a Self-Driving Car? IEEE Spectrum, 28-31.

[10] Guizzo, E., & Ackerman, E. (2016, June). When Robots Decide to Kill. IEEE Spectrum, 38-43.

[11] Hill, C. (2015, December 04). 10 jobs robots already do better than you. Retrieved December 28, 2016, from http://www.marketwatch.com/story/9-jobs-robots-already-do-better-than-you-2014-01-27

[12] Lee, J. (2014, July 21). 6 Human Jobs That Computers Will Never Replace. Retrieved December 28, 2016, from http://www.makeuseof.com/tag/6-human-jobs-computers-will-never-replace/

[13] Lucky, R. (2016, May). Are Engineers Designing their Robotic Replacements? IEEE Spectrum, 27-27.

[14] Niemueller, T., & Widyadharma, S. (2003, July 8). Artificial Intelligence – An Introduction to Robotics .

[15] Robot. (2016, December 28). Retrieved December 29, 2016, from https://en.wikipedia.org/wiki/Robot

[16] Schank, R. C. (1987). What Is AI, Anyway?. Association for the Advancement of Artificial Intelligence.

[17] Strickland, E. (2016, June). Doc Bot Preps for the O.R. IEEE Spectrum, 32-37.

[18] Turing, A. M., Computing Machinery and Intelligence].

[19] Vision Guided Robotic Systems. (2016, May 5). Retrieved December 28, 2016, from https://en.wikipedia.org/wiki/Vision_Guided_Robotic_Systems

[20] West, D. M., & Karsten, J. (2015, October 26). How robots, artificial intelligence, and machine learning will affect employment and public policy. Retrieved December 28, 2016, from https://www.brookings.edu/blog/techtank/2015/10/26/how-robots-artificial-intelligence-and-machine-learning-will-affect-employment-and-public-policy/